M. Neutronics of the WNR Target/Moderator Relevant to Beam-Plug Design, G. J. Russell, LASL

Monte Carlo calculations have been made, for the present WNR target/moderator geometry, which are relevant to the subject of beam plug design for the high-current target (target 1) at the WNR. Measurements of the spatial distribution of the neutron surface flux from the target 1 water moderator have also been made; a summary of the results follows.

1. Effects of the Size of Collimation

The size of the collimation in a flight path alters the "field-of-view" which a detector or sample sees on the moderator surface. The magnitude of the effect depends on the energy of the neutrons of interest (see Fig. II-M.1). The calculated results shown are for a 6.5-cm-thick by 20-cm-high by 30-cm-wide CH_2 moderator surrounding the WNR Ta target. As can be seen in Fig. II-M.1, the number of neutrons leaking from the moderator surface does not vary directly as the ratio of areas viewed because of the spatial distribution of leakage neutrons. The 15-cm-diam (177 cm^2) "field-of-view" represents the maximum practical size neutron beam which can be extracted from target 1. The 11.3-cm-diam (100 cm^2) "field-of-view" represents a "standard" area quoted by other laboratories when describing moderator neutronics.

2. Effects of Lowering the WNR Moderator

The effects of flight-path neutronics resulting from lowering the moderator centerline relative to the nominal flight-path centerline were studied by moving a 100 cm^2 "field-of-view" vertically up the moderator surface. The effects are energy dependent and are illustrated in Fig. II-M.2. For example, for a 100 cm^2 "field-of-view " the lowering of the moderator centerline by 2.54 cm causes the neutron-beam intensities to decrease by 6.6% to 12% for the energies shown; the thermal neutron-beam intensities should closely follow the 1 eV neutron leakage.

3. Effects of a Shadow Plate

The effectiveness of a shadowplate for removing the high-energy neutrons from a moderated neutron beam was calculated. The "field-of-view" on the CH_2 moderator was first limited to 177 cm^2 and then further reduced by a variable-width shadow plate as shown in Fig. II-M.3. The results of the calculations are shown in Figs. II-M.4 and II-M.5, and depend on the neutron energy of interest and the energies of the neutrons which are considered to cause background problems.

4. Measured Spatial Distribution of Neutron Surface Flux

The spatial distributions of the neutron surface flux from the unpoisoned H_2O moderator in Al cans was measured using bare and Cd-covered Au foils. The WNR Ta target was centered vertically relative to the moderator. The results are shown in Figs. II-M.6 and II-M.7. The thickness of the H_2O was 7 cm.

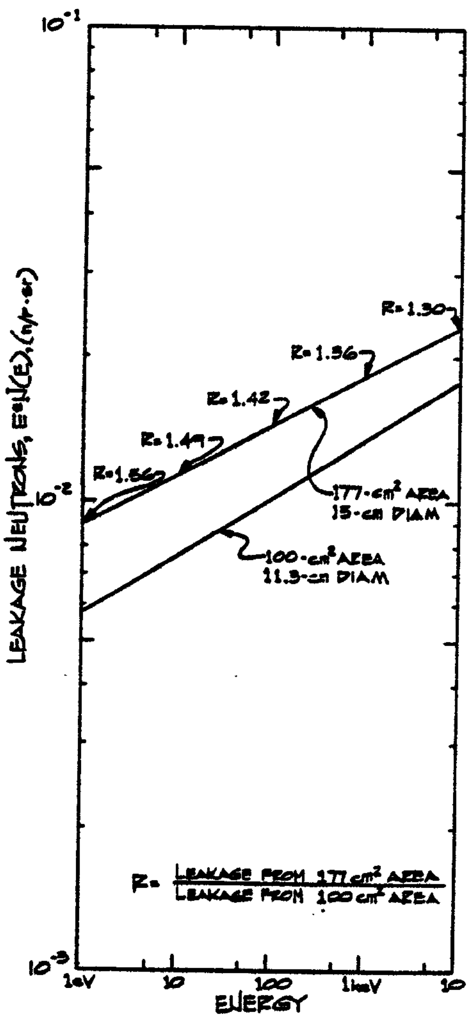

Fig. II-M.1. Calculated energy-dependent neutron beam leakage as a funtion of the "field-of-view" on the moderator surface.

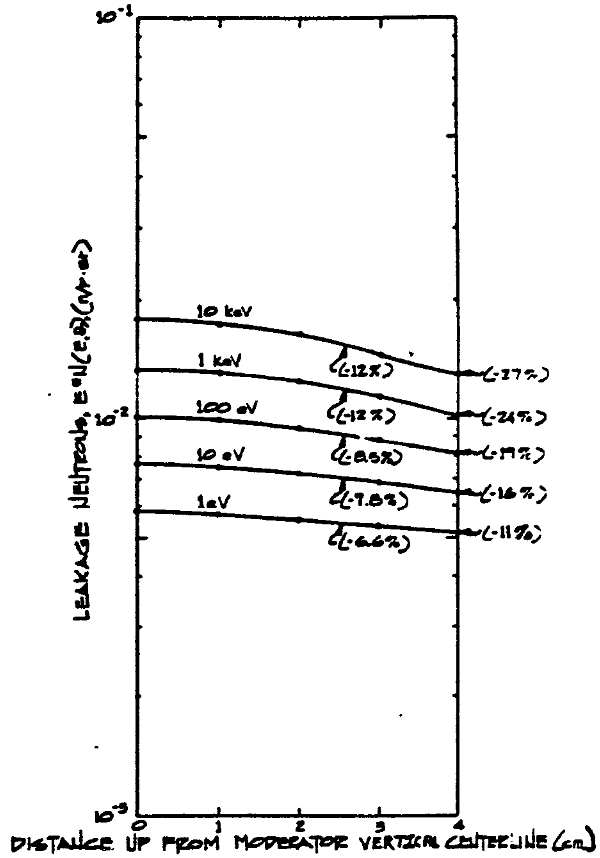

Fig. II-M.2. Calculated effect on neutron beam leakage of raising the "field-of-view" on the moderator surface. The percentages in parenthesis are relative to the "field-of-view" centered about the moderator centerline.

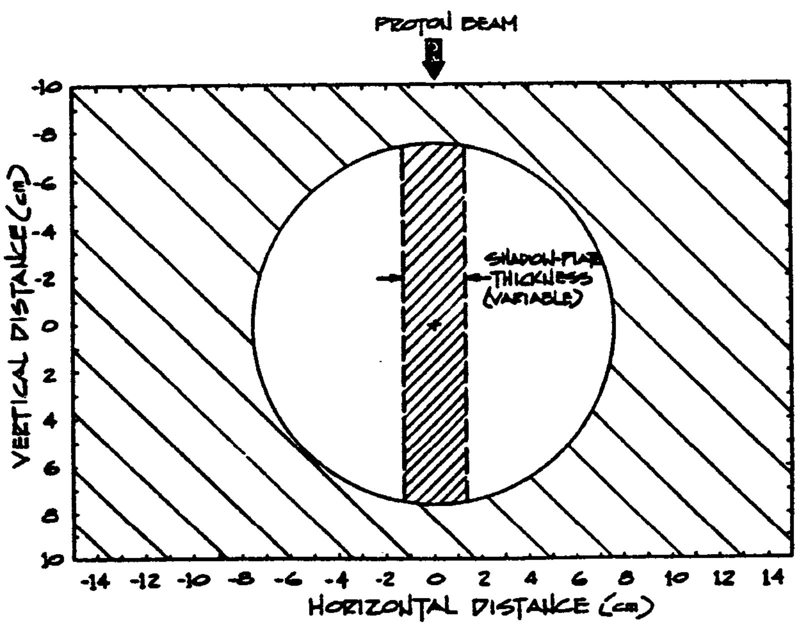

Fig. II-M.3. Illustration of first limiting the "field-of-view" on the moderator surface by collimation and then restricting the "field-of-view" further by use of a shadow plate.

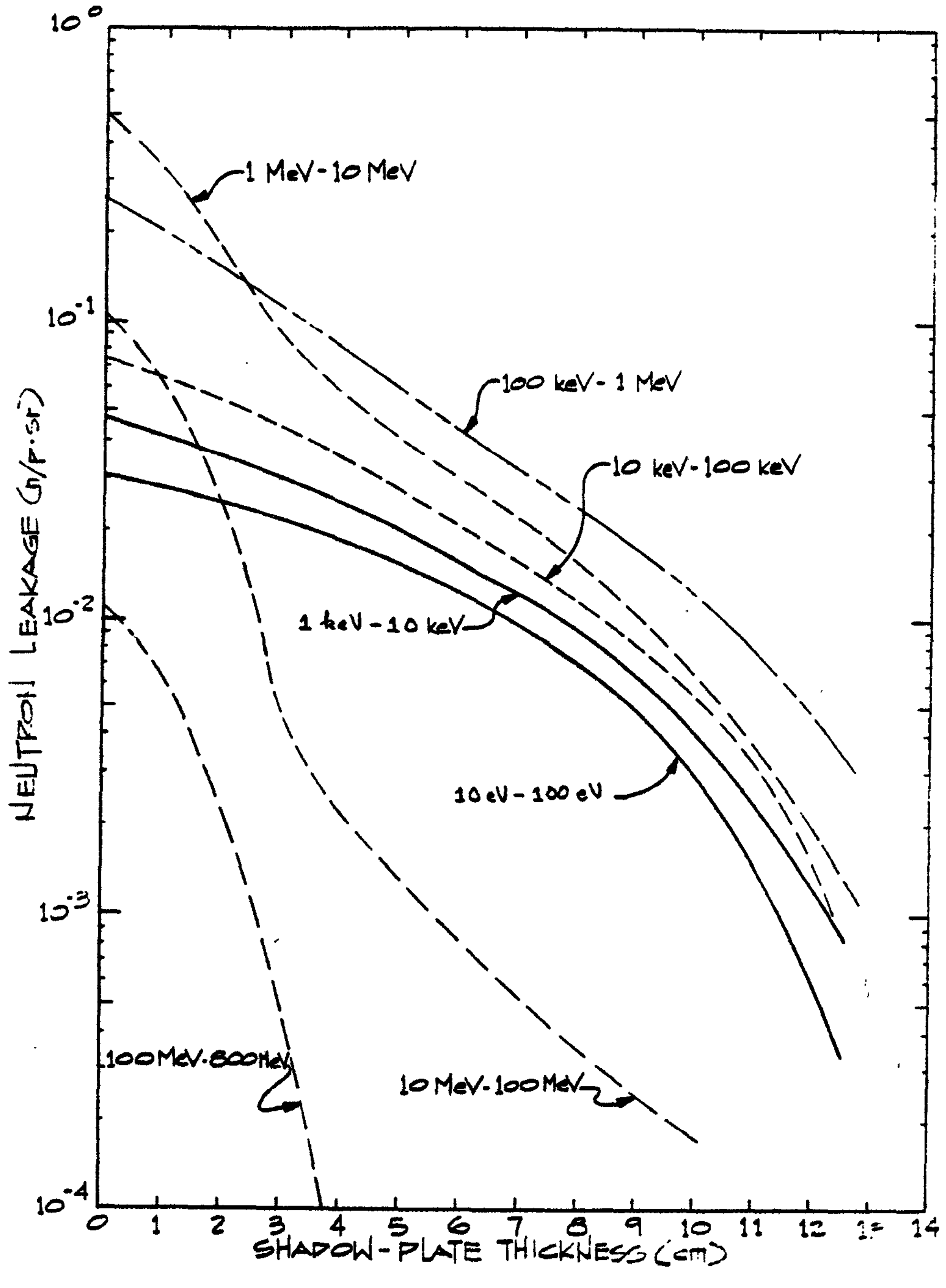

Fig. II-M.4. Calculated effect on neutron beam leakage of varying the thickness of a shadow plate. The solid lines represent potential neutrons of interest and the dashed lines possible neutron background contributors.

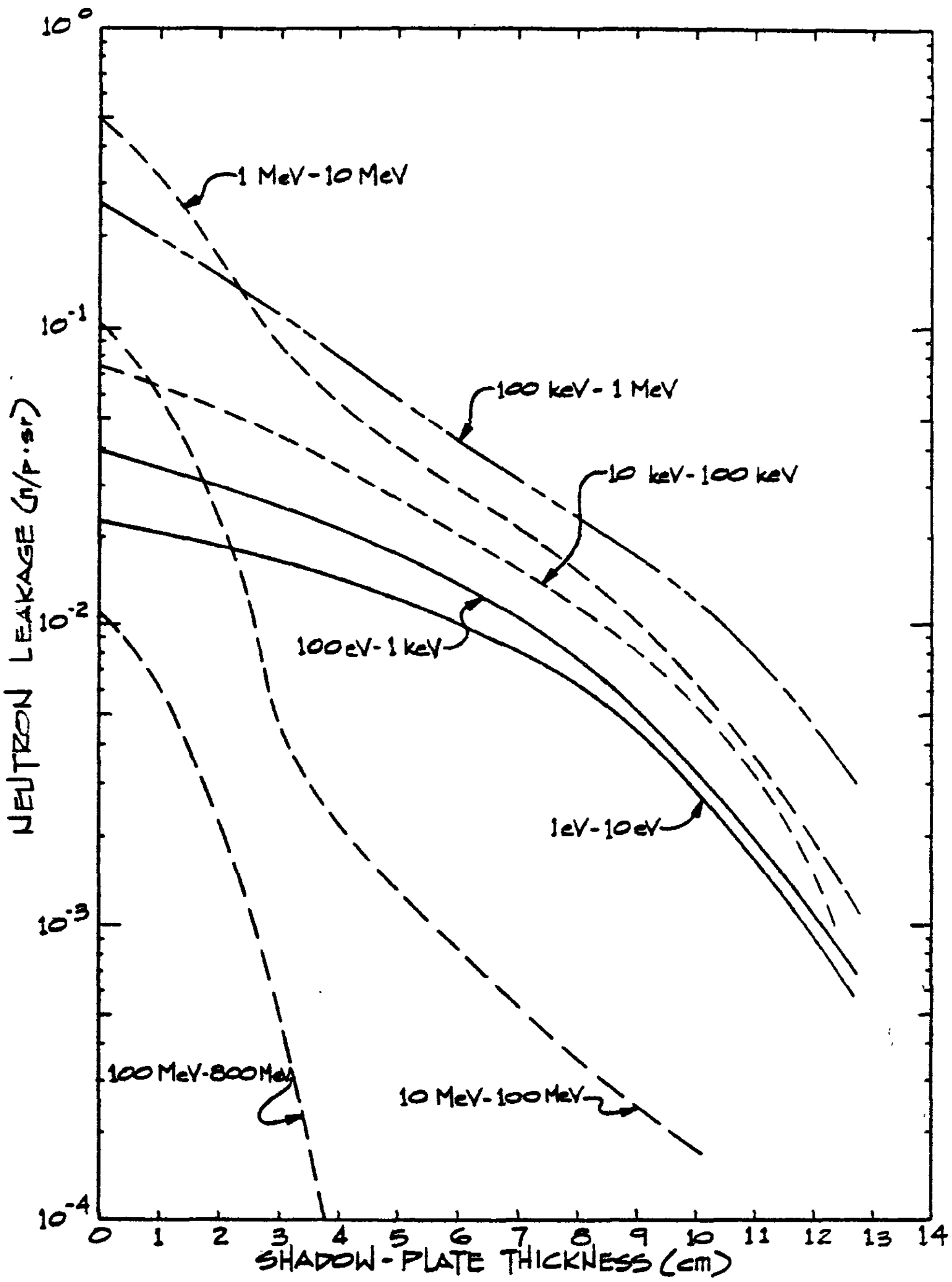

Fig. II-M.5. Calculated effect on neutron beam leakage of varying the thickness of a shadow plate. The solid lines represent potential neutrons of interest and the dashed lines possible neutron background contributors.

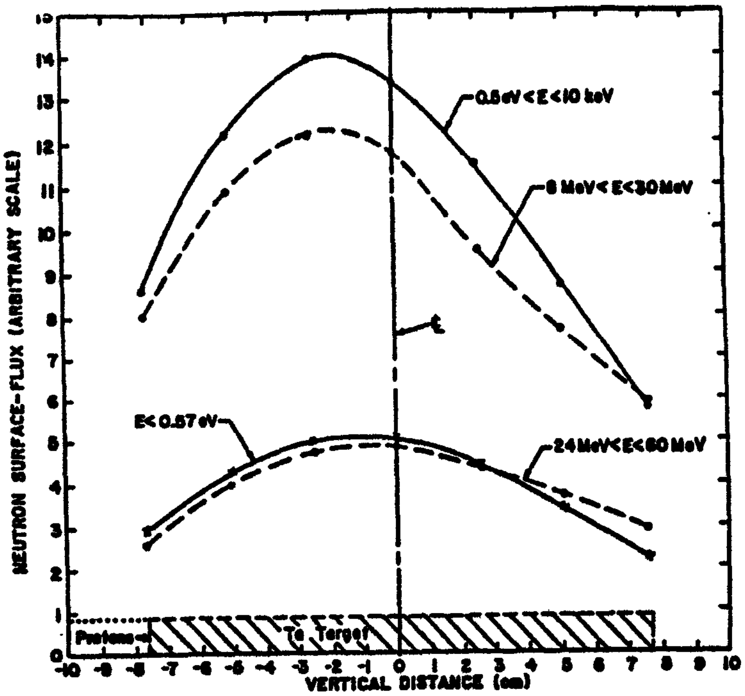

Fig. II-M.6. Measured vertical distributions of the neutron surface flux from the 20-cm by 30-cm surface of the WNR H_2O moderator. The measurements were made along the axis of the target.

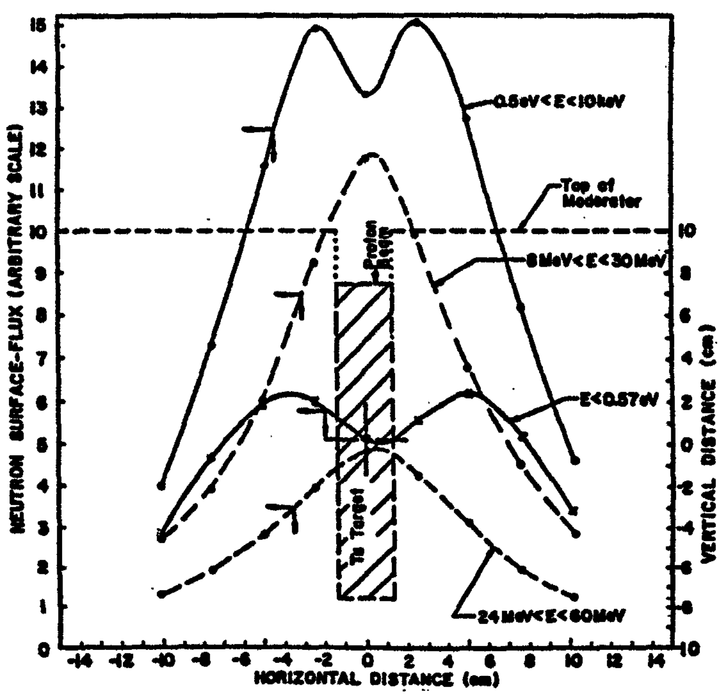

Fig. II-M.7. Measured horizontal distributions of the neutron surface flux from the 20-cm by 30-cm surface of the WNR H_2O moderator. The measurements were made along the moderator centerline. The left axis shows the neutron surface flux and the right axis shows the vertical size of the target/moderator configuration.